Process Modeling of Flow, Transport, and Biodegradation in Landfill Bioreactors

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The need to control gas and leachate production and minimize refuse volume has motivated laboratory experiments and model development for design and assessment of bioremediation treatment processes. In parallel with landfill bioreactor laboratory experiments, we have developed **T2LBM,** a module for the **T**OUGH**2** multiphase flow and transport simulator that implements a **L**andfill **B**ioreactor **M**odel. T2LBM provides simulation capability for the processes of aerobic or anaerobic biodegradation of municipal solid waste and the associated three-dimensional flow and transport of gas, liquid, and heat through the refuse mass. T2LBM considers the components water, acetic acid, carbon dioxide, methane, oxygen, and nitrogen in aqueous and gas phases, with partitioning specified by temperature-dependent Henry's coefficients. T2LBM incorporates a Monod kinetic rate law for the exothermic biodegradation of acetic acid in the aqueous phase by either aerobic or anaerobic microbes as controlled by the local oxygen concentration. Methane and carbon dioxide generation due to biodegradation with corresponding thermal effects are modeled. Acetic acid is considered a proxy for all biodegradable substrates in the refuse. Aerobic and anaerobic microbes are assumed to be immobile and not limited by nutrients in their growth. Although a simplification of complex landfill processes, T2LBM shows reasonable agreement to published laboratory experiments of biodegradation and gas production depending on the choice of numerous input parameters. Simulations of the landfill bioreactor laboratory experiments show that the mechanistic approach of T2LBM can be used to model bioremediation assessment indicators such as oxygen consumption associated with respiration tests.

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